Name: Example

AP Chemistry 2010-2011

Lab Binder

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Formal Lab Report Format

If possible, lab reports are to be typed so that students have an electronic copy of their work and printed out for inclusion in the Lab Binder. These may be double-sided to save paper.
If typing is not an option, students should hand-write the reports on composition notebook paper. If hand-written, use only one side of the paper.
The following sections should be included in every lab report:

Title (centered)
Date (centered)
Name (centered)

I. Objective(s):	In your own words, describe the purpose of the lab. *Use **complete sentences**.*
II. Concept(s):	*What concepts (theories, laws, etc.) are being illustrated in the lab? Use **complete sentences**.*
III. Pre-Lab Questions:	*Often, there will be questions to answer before carrying out the lab activity. When this is the case, the answers to the questions should be numbered and answered in **complete sentences**.*
IV. Procedure:	*The procedure will generally be given to you and you may write "see lab handout". If the procedure is not given to you, make sure to be as detailed as possible and number the steps.*
V. Data:	*Usually, a data table will be provided in the lab handout and you can record your data directly in the lab handout and write "see lab handout".* *Sometimes, you will be expected to construct your own data table. If the latter is the case, include data that is qualitative (observations) and/or quantitative (measurements) in this section.* *Measurements must include proper units and significant figures.* *Graphs and data tables may either be hand-written or computer-generated.*
VI. Analysis:	*Analysis questions will be included in each lab. These must be numbered and answered in **complete sentences**. Any calculations MUST be shown. Calculations should be <u>hand-written</u>.*
VII. Discussion & Conclusion	*This section should include a recap of what concepts, theories, and/or laws were illustrated in the lab activity. It should also include an explanation of your results and include sources of error – what went wrong and WHY? **Reflect on <u>what you learned</u> from this lab activity.** Use **complete sentences**.*

Place any lab handouts before the corresponding lab report. All pages in the lab handout and report should be numbered. Place the page number at the center and bottom of the page and circle it. The first page of the very first lab report handout should be numbered as page 7. All subsequent pages are to be one higher than the previous page.

NAME

THE DETERMINATION OF THE PERCENT WATER IN A COMPOUND

There is a good chance that you are sitting near several hundred pounds of hydrates at this very moment, because both plaster and cement, two of the most important building materials, are hydrates.

The polarity of the water molecule, which makes it a great solvent for ionic compounds, causes water molecules to cling to the structure of many solid substances. When this occurs, the trapped water molecules are called **water of hydration** and they become an integral part of the crystal structure.

The object of this lab is to determine the formula of a hydrate, a chemical substance of definite composition formed from, most commonly, ionic compounds and water molecules. A common hydrate is bright blue copper sulfate pentahydrate (5 waters of hydration), $CuSO_4 \bullet 5H_2O$. The dot indicates that water molecules are bound to the copper and sulfate ions in a definite proportion. Water bound in this manner is called a *ligand.*

Hydrates that have had their water molecules removed or "driven off", usually by heating, are called **anhydrous salts** ("without water"). A commonly used anhydrous salt is calcium chloride, $CaCl_2$, better known as "road salt". The anhydrous form avidly picks up water to form a hexahydrate (six waters of hydration). This hydration process is exothermic, generating heat which helps to melt the snow and ice on roadways during winter.

Like calcium chloride, there are many compounds that have a tendency to absorb water vapor from the air. These compounds are said to be *hygroscopic,* and can be used as moisture-reducing agents ("dessicants"). Some hygroscopic compounds absorb such large quantities of water vapor that they will actually dissolve in their own water of hydration, a property known as *deliquescence.*

In this experiment, you will test a hygroscopic ionic compound (hydrate) to determine its water of hydration. Although the water molecules are securely attached to the ionic solid that you will test, they are susceptible to removal by heat. You will heat a sample of the compound to drive off the water of hydration. By measuring the mass of the sample before and after heating, you can determine the amount of water in the sample and calculate its water of hydration.

OBJECTIVES

- Determine the percent by mass of water in magnesium sulfate (Epsom salt)
- Determine the formula of the hydrated form of magnesium sulfate

MATERIALS

Kimwipes, test tube, test tube tongs, microspatula, wire gauze, Bunsen burner, Epsom salt (magnesium sulfate hydrate) $\mathbf{MgSO_4{\bullet}nH_2O}$

Pre-lab Questions

1. What does "hygroscopic" mean?
2. Are hydrates compounds or mixtures? Explain.
3. Calculate the gram formula mass of $MgSO_4$.
4. Calculate the gram formula mass of H_2O.

PROCEDURE

1. Obtain and wear goggles.
2. Measure and record the mass of a clean, dry borosilicate test tube. Wipe it clean with a Kimwipe – be careful not to touch the tube with your fingers during this lab (use a Kimwipe if cool and test tube tongs if hot), as the oils on your skin may rub off onto the test tube and affect your mass measurements. Record the mass of the test tube in the data table.
3. Place ~1 microspatula's worth of hydrate into your test tube and record the mass of the test tube + hydrate. Record the mass in the data table. Record your observations of the hydrate below:

- The Hydrate is a white substance.
- Has a soapy odor.
- Definite crystal shapes can be seen.

4. Light your Bunsen burner and adjust the flame so it is small. Grab your test tube + hydrate with the test tube tongs as directed by your teacher. Gently heat the test tube, moving it across the flame so as to heat the hydrate and then evaporate off the water that condenses near the top of the test tube. Heat until you see no more condensation coming off/in the test tube. Lay the test tube on the wire gauze to cool.
5. While your first sample is cooling, your partner can repeat steps 2 through 4 with another sample of the hydrate.
6. When the test tube with your first sample is cool enough to handle safely, take it to the analytical balance and measure and record the mass of the test tube and its contents.
7. Heat the test tube again for ~ 5 more minutes allow it to cool, and measure and record its mass.
8. Continue heating, cooling, and measuring the mass of the test tube + contents until you have two mass measurements that are within about 0.050 g of one another.
9. Record observations of your anhydrous salt below:

- The anhydrous salt is a white substance.
- The anhydrous salt is lumpy and more brittle than the hydrate.

10. **Clean up:** rinse out your test tube with water and turn it upside down to dry in the designated drying rack.

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DATA TABLE SAMPLE DATA

		Trial 1	Trial 2
Mass of test tube (g)	(A)	19.43g	18.92g
Mass of test tube and hydrate (g)	(B)	21.02g	19.97g
Mass of hydrate (g)	C = (B − A)	1.59g	1.05g
Mass of test tube and anhydrous salt – 1st weighing (g)		20.79g	19.52g
Mass of test tube and anhydrous salt – 2nd weighing (g)		20.20g	19.03g
Mass of test tube and anhydrous salt – 3rd weighing (g)	D	20.20g	19.02g
Mass of anhydrous salt (g)	E = (D − A)	0.77g	0.10g
Mass of water evolved (g)	F = (C − E)	0.82g	0.95

ANALYSIS

1. Calculate the mass of your hydrate.
2. Calculate the mass of anhydrous salt.
3. Calculate the number of moles of anhydrous salt in your hydrate.
4. Calculate the mass of the water lost during heating.
5. Solve for moles of water in your hydrate.
6. Find your mole ratios.
7. Determine the formula of your hydrate.
8. Calculate the percent water by mass of your hydrate.
9. Calculate your percent error.

DISCUSSION AND CONCLUSTION

Your value for "n" should have been 7. Explain how your results compared to the theoretical value of 7. In this section, be sure to explain any concepts, theories, or laws that this lab demonstrated, how your results compare to the theoretical value of 7 for moles of water, possible sources of error and HOW those errors would have affected your experimental value.

Ex: If you had not heated the sample long enough to remove all the water of hydration, how would your experimental value of n have been affected? If some of your sample spattered out of the test tube when heating and was lost, how would this have affected your experimental value of n?

Determination of the Percent Water in a Compound

September 10, 2010

Miss Regan

I. OBJECTIVE: The purpose of this lab is to determine the formula of magnesium sulfate, a hydrate.

II. CONCEPTS: One of the concepts illustrated in this lab is the Law of Definite Proportions because hydrates are substances with a constant composition. Another concept is the Law of Conservation of mass. This law is used to determine the mass of water present in the hydrated compound. Once the mass of water is determined, the formula of the hydrate can be found.

III. PRE-LAB QUESTIONS

1. The term "hygroscopic" refers to the ability of a compound to attract water molecules present in the surrounding air.

2. Hydrates are compounds because they have a constant composition. Mixtures, such as salt water, have varying compositions, which means that a mixture of salt and water can have different ratios of salt to water.

3. (Example- GFM of Na_2CO_3 instead of $MgSO_4$)

(long way) →

Na	2 ×	40.08 g	=	22.99 g
C	1 ×	12.01 g	=	12.01 g
O	3 ×	16.00 g	= +	48.00 g
				83.00 g/mol

(short cut way) →

4. GFM H_2O = 2(1.008 g) + 16.00 = **18.02 g/mol**

IV. PROCEDURE: See Lab handout, page 8

V. DATA: See Lab handout, pages 8-9

VI. ANALYSIS:

1. Mass of hydrate = mass of test tube + hydrate − mass of test tube

· Trial 1: mass of hydrate = 21.02 g − 19.43 g = **1.59 g**

· Trial 2: mass of hydrate = 19.97 g − 18.92 g = **1.05 g**

2. Mass of anhydrous salt = final mass of anhydrous salt + test tube − mass of test tube

· Trial 1: mass of anhydrous salt = 20.20 g − 19.43 g = **0.77 g**

· Trial 2: mass of anhydrous salt = 19.02 g − 18.92 g = **0.10 g**

3. moles anhydrous salt = mass anhydrous salt ÷ GFM anhydrous salt

· Trial 1: moles Na_2CO_3 = 0.77 g $\left(\frac{1 \text{ mol } Na_2CO_3}{83.00 \text{ g}}\right)$

= **0.009277 mol Na_2CO_3**

· Trial 2: moles Na_2CO_3 = 0.10 g $\left(\frac{1 \text{ mol } Na_2CO_3}{83.00 \text{ g}}\right)$

= **0.001205 mol Na_2CO_3**

4. mass of H_2O lost = mass of hydrate − mass of anhydrous salt

· Trial 1: ~~grams H_2O =~~ grams H_2O = 1.59 g − 0.77 g = **0.82 g H_2O**

· Trial 2: grams H_2O = 1.05 g − 0.10 g = **0.95 g H_2O**

*Note: If there are multiple trials, you only have to show calculation setup for one trial. I did both trials to provide more examples for you.

VI. ANALYSIS (continued)

5. mol H_2O = mass H_2O ÷ GFM H_2O

· Trial 1: mol H_2O = $0.82g\left(\frac{1\,mol\,H_2O}{18.016g}\right)$ = **0.045 mol H_2O**

· Trial 2: mol H_2O = $0.10g\left(\frac{1\,mol\,H_2O}{18.016g}\right)$ = **0.053 mol H_2O**

6. Mole ratios = moles anhydrous salt : moles water

· Trial 1: 0.009277 mol Na_2CO_3 : 0.045 mol H_2O

· Trial 2: 0.001205 mol Na_2CO_3 : 0.053 mol H_2O

7. To Determine the formula of the hydrate, divide both mole values by the smaller number:

· Trial 1: $\frac{0.009277\,mol\,Na_2CO_3}{0.009277\,mol}$: $\frac{0.045\,mol\,H_2O}{0.009277\,mol}$

⇒ $Na_2CO_3 \cdot 4.85\,H_2O$ ≈ **$Na_2CO_3 \cdot 5H_2O$**

· Trial 2: $\frac{0.001205\,mol\,Na_2CO_3}{0.001205\,mol}$: $\frac{0.053\,mol\,H_2O}{0.001205\,mol}$

⇒ $Na_2CO_3 \cdot 43.9\,H_2O$ ≈ **$Na_2CO_3 \cdot 44\,H_2O$**

8. % water by mass = $\frac{\text{mass of water}}{\text{mass of hydrate}} \times 100$

· Trial 1: % water = $\frac{0.82g}{1.59g} \times 100$ = **52% H_2O**

· Trial 2: % water = $\frac{0.95g}{1.05g} \times 100$ = **90.% H_2O**

9. % error = $\frac{|\text{experimental} - \text{actual}|}{\text{actual}} \times 100$

actual value for "n" is 7

· Trial 1: % error = $\frac{|5-7|}{7} \times 100$ = **29%**

· Trial 2: % error = $\frac{|44-7|}{7} \times 100$ = **530%**

↑ % error can be over 100!

VII. Discussion and Conclusion

This lab demonstrated both the law of definite proportions and the law of conservation of mass. Because hydrates are compounds with a constant composition and because the waters of hydration (water molecules bound to the salt crystals) can be relatively easily driven off by heating, the amount of water ~~can be calculated~~ present in the hydrate can be calculated.

The closest value obtained in the experiment for n was in Trial 1. The experimental value of 5 was slightly less than the expected value of 7. This may have been due to incomplete removal of all the waters of hydration during this trial. The smaller value of n may also have been caused by accidentally touching the test tube with my fingers instead of using the test tube tongs, as the oils on my hands could have rubbed off onto the glassware and given a ~~larger~~ [smaller] than actual mass value. If the anhydrous salt was not thoroughly cooled [for the water driven off.] before massing, this may also have created a convection current above the electronic balance of upward moving air, which would result in a smaller mass value.

The extremely large percent error for Trial 2 was most likely caused by accidental spattering of the hydrate while heating. A fairly large amount of hydrate was lost during the spattering, which would cause the mass of water evolved value to be extremely large and thus give an extremely large value for n.